

Subject: RE: arbcombo -- Air Cleaner Regulation Comments

From: Cherie Brook <cbrook@prozoneint.com>

Date: Mon, 02 Jul 2007 19:08:41 -0500

To: mjenkins@arb.ca.gov

CC: slum@arb.ca.gov, 'ronald barnes' <ronaldbarnes@hotmail.com>, rbarnes@prozoneint.com

Per your request, we have the following comments regarding the proposed California Air Board standard.

1) No differentiation is made as to the type of ozone generating devices. There are substantial differences between corona discharge and ultraviolet ozone generators. See attached white paper. Most of the negative effects normally attributed to ozone may be due to nitrogen oxides which are produced by corona discharge devices (similar to ground level ozone or smog). These byproducts are not produced by ultraviolet ozone generators, which produce pure ozone (similar to that produced by the sun in the atmosphere).

Pure ozone, in of itself, is a non-toxic irritant. Even high levels of pure ozone that can possibly be produced by a household rated machine have biological symptoms that reverse within 24 hours of exposure, unlike the toxic components listed below. The symptoms for toxic chemicals are accumulative and have permanent biological effects. Pure ozone producing devices should have a separate category or should be separated from devices producing toxins.

2) Many air purification devices produce harmful and toxic byproducts, not just those which also produce ozone. We have reviewed several proposed air purification and sanitation systems that intentionally or inherently emit toxic chemicals that include:

Chlorine dioxide

Nitrogen Oxides:

NOX

NO

NO₂

N₂O

N₂O₂

Hydrochloric Acid

Carbon Monoxide

Formaldehyde

Chloroforms

Carbon Tetra Chloride

Sodium Chloride

Potassium Chloride

Sodium Hypochlorite

Aldehydes

Aromatic Chemicals such as Vicks

Other ketones

Charged micro-particulate

Metallic Ions – silver, copper, zinc

It may be interesting to note, that in addition to ozone, the same above components also exist in a smog environment.

3) Excluding air duct mounted devices appears to be an intentional political oversight in a high volume application that far exceeds limitations on portable air purification systems.

4) Limiting the standard to prevent the use of ozone generators in unoccupied spaces - even if a timer or ozone annihilator is integrated into the product - radically reduces the capability and the versatility of the products and prevents the products from being utilized for their intended use. The standard ignores the great benefits that can be derived from ozone and advanced oxidation process and gives no relevance to the fact that the benefits far outweigh the minute negative byproducts of the reactions produced by ozone. It is a disservice to those who need to eliminate mold and for fire restoration - areas of proven success for temporarily unoccupied areas.

5) If there is to be a limitation on the air quality devices, then control must be 'an across the board evaluation' which should include consideration of all of the above listed byproducts. The consequence of the narrowly focused standards may increase marketing of these devices as a direct response to the limitations on air purification and sanitation systems that do not fall under the current guidelines of the proposed ozone standard.

6) The economic survey failed to consider the total cost of engineering, marketing, lost sales and the cost of poor and confusing consumer education that will evolve from such a biased and narrowly focused standard.

It is nonsensical singling out portable ozone producing air purifiers for a disproportionate air quality standard, when California has failed to control any of the above components in the Clean Air Act for California.

We would be happy to answer any further questions. Please send your comments or questions to the e-mail addresses listed above.

Sincerely,

Cherie Brook

256-539-4570 ext.21

From: slum@arb.ca.gov
 Reply-To: slum@arb.ca.gov
 To: post-arbcombo@listserv.arb.ca.gov
 Subject: *arbcombo -- Air Cleaner Regulation: Workshop Video Available*
 Date: *Fri, 22 Jun 2007 15:38:50 -0700*
 >A video of the Air Cleaner Regulation Workshop held on June 11,
 >2007 is now available for viewing. Access to the video can be
 >found at
 ><http://www.arb.ca.gov/research/indoor/aircleaners/aircleaners.htm>
 >
 >
 >As a reminder, comments on the revised draft regulation, the
 >Draft Economic Impacts Assessment document and the Draft
 >Certification Application Form are due Monday, July 2, 2007.
 >However, we would appreciate submittal prior to that date if
 >possible.
 >
 >For copies of the revised regulation, the Draft Economic Impacts
 >Assessment document or the Draft Certification Application Form
 >please visit the following site to download the documents:
 ><http://www.arb.ca.gov/research/indoor/aircleaners/aircleaners.htm>
 >
 >
 >For questions regarding the draft regulation or the Draft

>Economic Impacts Assessment document, please contact Peggy
>Jenkins, Manager, Indoor Exposure Assessment Section, California
>Air Resources Board, at mjenkins@arb.ca.gov, or 916-445-0753.

>

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Prozone Air Purifier Testing - White paper.doc

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Testing of Ozone Air Purifiers

Introduction

Ozone Production

Ozone air purifiers produce ozone either by irradiating the air with ultraviolet light at 185 nm or exposing the air to a high voltage electrical field (Corona Discharge). With either generation method, a portion of the oxygen (O₂) in the exposed air is split in two, resulting in the formation of monatomic oxygen (2ea O[•]). The monatomic oxygen recombines with oxygen (O₂) to form ozone (O₃). The reactions can also be represented as:

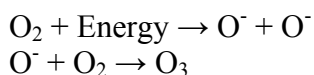


Figure 1

In the case of ultraviolet ozone generation, the energy provided is from photons (light) emitted from a specialized ultraviolet lamp. Energy provided by corona discharge is in the form of electrons created in a high voltage electric field. When either the electron or photon interacts with bond holding oxygen together, the reactions shown in Figure 1 occur.

The difference in the manner in which ozone is created is critical to understanding why most of the ozone exposure studies performed is flawed and inaccurate. Specifically, ozone created using the ultraviolet method of generation only produces pure ozone while the corona discharge ozone generation process creates ozone, nitrous oxides, and nitric acid. Nitrogen oxides compounds, as will be demonstrated later in the article, are toxic and exposure to them generates many of the symptoms that are attributed to ozone exposure in humans.

Ultraviolet ozone generation, as previously mentioned, creates ozone by exposing ambient air to high energy photons which are created by specialty lamps. These photons are emitted at a frequency of 185 nm. This frequency determines the maximum energy that a photon can impart to oxygen (O₂). By simple calculation (using Planck's Law), it can be demonstrated that the amount of energy in the light created by ozone generating lamps is enough to create ozone, but too low to create nitrous compounds.

Corona discharge ozone generation is a much dirtier process. An electric field generates high energy electrons which not only have sufficient energy to split oxygen as shown in Figure 1, but also nitrogen (N₂). So when corona discharge is used to create ozone, the following reactions occur:

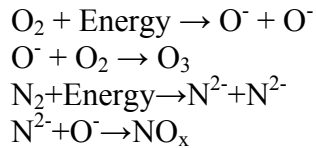


Figure 2

These reactions will occur anytime nitrogen is present with oxygen when ozone is created using the corona discharge process. When a home type corona discharge ozone generator is used, the quantity of nitrogen oxides produced may equal or even exceed the quantity of ozone produced, making the unit, in effect, a smog generator.

<Insert WQA NO_x v O₃ Production Graph>

More sophisticated corona discharge devices (generally commercial grade devices) use oxygen concentrators to reduce the quantity of nitrogen in the air fed to the device. Oxygen concentrators pass air through a specialized material which absorbs nitrogen and provides air which is approximately five (5) percent nitrogen and ninety-five-percent (95) oxygen. However, despite the significant reduction in nitrogen, nitrogen oxides will still form. The only way to totally eliminate their formation is to supply one-hundred (100) percent oxygen to the generator.

One additional problem that occurs when nitrous compounds are generated in the corona discharge process is the formation of nitric and nitrous acids which form when the nitrogen dioxide (NO₂) generated in the corona discharge process interact with the water in air. This problem can be reduced through the use of oxygen concentrators and/or air dryers. While oxygen concentrators are never found on home type purifiers, some devices may come with desiccant type dryers. These dryers typically saturate quickly and if they are not replaced rapidly become useless.

Summary of Ozone Production

- Ultraviolet ozone generators produce only pure ozone.
- Corona discharge ozone generators used for home purification produce considerable quantities of nitrogen oxides, nitric and nitrous acids.
- Corona discharge units which use oxygen still produce nitrous oxides.
- Exposure to nitrogen oxides produces symptoms similar to those attributed to ozone exposure.

Medical Effects of Exposure to Nitrous Compounds

Nitrogen oxides represent a mixture of gasses which are commonly represented with the formula NO_x . NO_x represents gases which include NO, NO_2 , N_2O_3 , N_2O_4 , and N_2O_5 . Nitrous oxide, which is used as an anesthetic and is commonly known as laughing gas, is different from the NO_x series and is not an issue in this discussion. As previously discussed, nitrogen dioxide forms a mixture of nitric and nitrous acids when exposed to moisture.

Nitrogen oxides are toxic and irritating to the respiratory system even at low concentrations (50 ppm). Exposure to these gasses may also result in coughing, fatigue, nausea, headache, abdominal pain, difficulty breathing and pulmonary edema. After several weeks, scarring which results from exposure may result in coughing, rapid, shallow breathing, rapid heartbeat, and inadequate oxygen flow. Asthmatics and persons with heart disease are particularly at risk when exposed to nitrogen oxides.

Most of the nitrogen oxides will irritate the respiratory system. Nitrogen dioxide is one of the most problematic nitrogen oxides. It damages the lungs in three ways:

- Nitrogen dioxide converting to acid (nitric and nitrous) in the upper airways which in turn directly damages the respiratory system.
- Free radical generation which damages cell membranes, oxidizes proteins, and damages lipids.
- Reduces resistance to infection by altering the immune system.

Nitrogen dioxide is responsible for the smell that is associated with corona discharge type ozone generators (particularly those using untreated air).

Summary of Nitrogen Oxides

- Nitrogen oxides are toxic.
- Nitrogen dioxide, which is produced in the corona discharge process, can damage the respiratory system in multiple ways.
- Nitrogen oxides will be produced in the corona discharge process unless pure (100 percent) oxygen is used.

Medical Effects of Ozone

A partial list of the effects of human exposure to ozone is very similar to those listed in literature for nitrogen oxides. The table below summarizes these effects and lists whether the effect attributed to ozone can also be attributed to nitrogen oxides.

Effect of Exposure	Ozone	Nitrogen Oxides
Respiratory		
Decrease in Lung Function	Yes	Yes
Cough	Yes	Yes
Throat Irritation	Yes	Yes
Chest Tightness or Pain	Yes	Yes
Shortness of Breath	Yes	Yes
Inflammation of Lung Tissue	Yes	Yes
Higher Susceptibility to Respiratory Infection	Yes	Yes
Non-Respiratory Effects		
Headache	Yes	Yes
Nausea	Yes	Yes
Weakness	Yes	Yes
Dizziness	Yes	Yes

Figure 3

A partial survey of exposure studies indicates that exposure studies for ozone have been run primarily with corona discharge ozone generators using oxygen concentrators or untreated air. It does not appear that the deleterious effects of exposure to nitrogen oxides, particularly nitrogen dioxide, is addressed or considered by most researchers. A comprehensive study of ozone exposure studies will be required to address this issue and categorize test set-ups and conclusions. It appears likely, however, that nitrogen oxides play a significant role in the assessments made by most ozone exposure studies.

Summary of Medical Effects of Ozone

- Symptoms of exposure to ozone match those of exposure to nitrogen oxides.
- The majority of exposure studies use corona discharge type equipment with and without oxygen.
- Most studies do not consider the fact that nitrogen oxides could be causing the symptoms attributed to ozone.